

I. A REVISION OF THE INDIAN SPECIES OF THE GENUS *PHYLLOBOTHRIMUM*.

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(With Plate I.)

During recent years large numbers of Cestoda have been collected in India and Ceylon. Except in a few instances the descriptions of such of these parasites as have been described have been based almost exclusively on external characters, and such characters are often insufficient to identify the parasite. The variability of form assumed by all cestodes during the process of preservation, and the differences due to age and between the mature and immature worms, makes identification by means of external characters alone very difficult. Further, descriptions of parasites which do not include an account of the anatomy cannot be regarded as satisfactory.

The genus *Phyllobothrium* was first defined by Van Beneden in the year 1849. Unfortunately, we have been unable to obtain a copy of the original memoir. In 1850 he published a description of the two species *P. thridax* and *P. lactuca*, while in 1858 he described the species *P. auricula*. A description of two more species, *P. brassica* and *P. fallax*, followed in 1871.

In 1850 the same author (1) defines the characters of the genus *Phyllobothrium* as follows:—

“The four bothridia are sessile; their concavities face externally. They are very mobile and have their edges frilled and puckered like the leaves of a lettuce.”

In 1888 Zschokke (14) published a very careful account of the anatomy of *P. thridax* and *P. dohrni* (*Orygmatobothrium dohrni*). An excellent description of *P. vagans*, Haswell, was given by Haswell (8); and quite recently Yoshida (13) has given a further account of the anatomy of *P. lactuca*, Van Ben. Linton (5) described two species *P. foliatum* and *P. thysanocephalum*, and also added some notes on Leidy's species *P. loliginis*, but he eventually found it necessary to establish the genus *Thysanocephalum* for his *P. thysanocephalum* and changed the name of this species to *Thysanocephalum crispum*, though according to the accepted rules of zoological nomenclature it should be known as *T. thysanocephalum*.

Shiple and Hornell (11) described three new species, viz.—*P. blakei*, *P. minutum* and *P. pammicrum*, from external characters alone, giving no account of their anatomy. Shiple had also

described previously a species *P. dipsadormorphi* from a snake (10). The genus *Phyllobothrium* usually infests fish-hosts, but the following four species have been described from other animals or without identification of the host.

1. *P. dipsadormorphi* from the "Malagea" snake—*Dipsadormorphus irregularis*.
2. *P. delphini* from the Dolphin—*Delphinus tursio*.
3. *P. inchoatum* from the whale—*Mesoplodon sowerbiensis*.
4. ? *P. crispatisissima* and *P. variabile*. Hosts unknown.

The total number of species recorded up till now is 20.

Our collection comprises five species only (viz. *P. blakei*, *P. pammicrum*, *P. foliatum*, *P. lactuca*, *P. compacta*), and represents all the known Indian species except *P. minutum*.

A point worthy of note in connection with the general anatomy of the genus is the presence of supplemental discs on the bothridia in some of the species and their absence in the others. Until the anatomy of the genera closely allied to *Phyllobothrium* has been more fully worked out, it is impossible to discuss the exact relationships of the genus, though it is probable that an elucidation of the anatomy of species belonging to the closely allied genera may necessitate a new grouping of the species.

Phyllobothrium lactuca, Van Beneden.

(Plate I, fig. 1.)

Five specimens from the spiral valve of *Galeocерdo tigrinis*, Müll. and Henle, Ceylon Pearl Banks, December 1910.

Van Beneden's account (1) of the anatomy of this species is somewhat meagre. A further account has recently been given by Yoshida (15) which also is incomplete. Johnstone (4) suggests that Van Beneden's figure of this species was drawn from a specimen in which the bothridia had undergone extreme contraction, the head as a result having assumed a spherical appearance and consequently presenting very little indication of the true shape of the bothridia. Johnstone's figure of the head of *P. lactuca* consequently differs somewhat from Van Beneden's figure of the same species.

The worm was recorded from the Ceylon Pearl Banks by Shipley and Hornell (11), who obtained it from the intestine of *Trygon walga*. These authors state that their specimens resemble Van Beneden's figure except that the four bothridia are more distinct. The voluminous head of *P. lactuca* naturally presents different appearances according to the condition of preservation. Our specimens resemble the figure given by Van Beneden in having the head compact and somewhat rounded in shape, though the four bothridia are quite separate.

The specimens, which were preserved in spirit, measure 12 cms., 15 cms., 16 cms., 17.5 cms., and 24 cms., respectively. No measurements of the living worms were taken, but very considerable

contraction was noticed on transferring them to spirit. The greatest breadth of the preserved specimens varies from 3 to 4 mm., and the breadth of the head from 3.5 mm. to 5 mm. In the living condition it was noticed that the worms are capable of very great elongation. The great mobility of the bothridia, noted by Van Beneden, was also observed in the living specimens.

Free proglottides were found in great abundance in the spiral valve of *Galeocerdo tigrinis*. They varied in shape and degree of maturity. The anterior extremity of the mature proglottid is very much reduced, and the sides curve back from it to the broad and ruffled posterior margin.

We have nothing to add to the already existing accounts of the external characters of the worm but certain anatomical features call for remark, as they do not seem to have been noticed before. The reproductive system as seen in a fully mature and detached proglottid is first described, further on the structures as seen in a proglottid still attached to the body of the worm are also considered.

Male organs. The testes (T) consist of numerous rounded structures occurring from near the anterior pointed portion of the proglottid to behind the genital opening. They occupy the central field and are situated at a much deeper level than the vitelline glands which lie external to them. Each testes is about .05 mm. in diameter and is much smaller than is shown by Van Beneden; moreover the number of testes in each proglottid is much larger than is shown in his figure. From each of the testes leads a fine duct, and the ducts from the various testes unite together to form a single median vas deferens (v.d). This duct is a very much coiled, elongated, tubular structure, which continues to the cirrus sac; the terminal portion forms the ejaculatory duct and the outer end of the tube is continuous with the outer extremity of the cirrus sac. At the time of protrusion the ejaculatory duct is a double tube, the outer tube being the everted part of the cirrus sac (c), while the inner tube is the terminal portion of the vas deferens. This evertible portion—the penis (P) or the cirrus—is unarmed.

Female organs:—The ovaries (ov.) consist of two large lobes, lying one on each side of the centre line, near the posterior end of the segment; they are connected with each other by a median isthmus. Each of the lateral halves is double, as has been described by Haswell for *P. vagans*. The margins of the ovaries are very much crenated. The oviduct (o.d) begins ventral to the isthmus in a pouch-like structure which is known as the “swallowing apparatus.” We have not been able to see in our preparations of *P. lactuca* the “plug” described by Haswell, and it appears that this structure is absent in *P. lactuca*. From the “swallowing apparatus” the oviduct runs backwards, ventrally to the shell gland (S.G.) and the receptaculum seminis (R.S), and then curves upwards and to the dorsal surface, it is then continued forwards dorsally to the vagina and the isthmus of the ovary to end blindly. In its course it

receives, just before curving upwards, the fertilising duct from the receptaculum seminis. The vitteline duct opens into it a little further on. The distal portion of the oviduct (which has been designated the ootype (P.U), or primary uterus, opens into the secondary uterus (S.U) by a longitudinal slit on the ventral surface of the secondary uterus. The secondary uterus is a large elliptical chamber, extending from close to the isthmus of the ovary to very near the anterior end of the proglottid. It has no external aperture and the dehiscence of the proglottid probably takes place in the same manner as has been described by Haswell for *P. vagans*. The shell-gland (S.G) is a compact structure surrounding that portion of the oviduct which is situated a little in front of the opening of the vitteline duct into the oviduct. As seen in sections, the shell-gland appears to be connected with the oviduct by minute tubules, through which the secretion is poured into the duct. The vagina (Va) opens immediately in front of the male opening by a fairly broad aperture into the shallow genital pit, which is situated nearer the posterior than the anterior extremity. Its terminal portion is swollen to form a barrel-shaped structure, which probably serves for the storage of spermatozoa until they can find their way to the bag-like receptaculum seminis at the end of the sinuous vaginal duct; from the barrel-shaped dilatation a thin tube leads backwards and upwards. A little above the origin of the main vas deferens this tube curves backwards and is continued, dorsal to the secondary uterus; eventually below the isthmus of the ovary it is dilated to form the vesicula seminalis. From the bay-like receptaculum seminis the fertilising duct leads to the oviduct, as has already been described.

The vitteline glands (V) are situated laterally throughout the length of the proglottid. They are ovoidal structures .4 mm. in diameter. A fine duct leads from each glandular unit, these tubules then unite into two ducts, one on either side, and the pair further unite to form a median duct, which opens into the oviduct a little below the shell-gland.

In the last attached segment the whole of the anatomy was made out in two cases. The secondary uterus is, however, in segments still attached, only a tubular structure without any eggs. In other details they resemble the free proglottides. In the more anterior segments all the structures are not developed and cannot be seen.

***Phyllobothrium foliatum*, Linton.**

(Plate I, figs. 2, 3.)

Four specimens from *Rhynchobatus djeddensis* (Försk.), Ceylon Pearl Banks, February 3rd, 1911.

Linton (5) described the species in 1890. His specimens were obtained from *Trygon centura* caught at Woods Hole, Mass., in 1887. He subsequently recorded the species from *Carcharinus obscurus* at Beaufort, North Carolina, July 11th, 1902. The spe-

cies has not been recorded since. His description is somewhat incomplete and his figures are not quite clear. We, therefore, figure the essential features of the anatomy of the worm again.

Three of our specimens, which were preserved in spirit, measure 5 cms. in length and the fourth measures 6 cms. The breadth of the posterior segments is 2 mm. and the length 3 cms.

All the four specimens have four supplemental discs in each case. These suckers appear to be formed by the fusion of a portion of the edge of the bothridium, and, in a casual examination, the frilled edge may occasionally be mistaken for a sucker, but in the specimens before us there are distinct suckers in each case. Linton (5) states that his *P. foliatum* has the bothridia pedicelled, in marginal pairs, a feature which would require a modification of the generic characters for including this peculiarity. In our specimens the bothridial pedicel is very short, and the bothridia may be described as practically sessile. No observations are available regarding these structures in the living specimens.

The anatomical details of a ripe proglottid of this species are exactly similar to those given for *P. lactuca* except that the vitteline glands in *P. foliatum* are confined to the lateral fields lying external to the excretory tube. Linton described the cirrus of *P. foliatum* as being echinate. In none of our worms was the cirrus protruded, but we were able to ascertain that no spines occur on the cirrus in these specimens. This character, therefore, appears to be variable in *P. foliatum*, although usually it is a constant feature in other species.

***Phyllobothrium pammicum* Shipley & Hornell.**

(Plate I, fig. 4.)

Over a dozen immature specimens from *Urogymnus asperrimus*, Ceylon Pearl Banks, February 16th, 1911.

Thirteen specimens from *Hypolophus sephen*, main area of Chilka Lake, December 1911.

Shipley and Hornell described this species from the intestine of *Carcharias melanopterus* caught at Dutch Bay, Ceylon, in 1905. They had only two specimens. In the original description only the external anatomy was dealt with.

One of us (14) recorded the occurrence of the same species in the intestine of *Hypolophus sephen*, whence 13 specimens were obtained. At the same time a short account of the anatomy was also given. We have, besides, specimens from the intestine of *Urogymnus asperrimus* from the coast of Ceylon.

The length of the various specimens varies from 4 to 5 mm., the maximum breadth up to, 3 mm., and the last segment is nearly 1 mm. long.

The head, which we figure, bears four sessile bothridia which have slightly thickened and crisped edges. There are no accessory suckers, and the neck is short.

There are a large number of testes of a fair size disposed on either side of the longitudinal axis of the proglottid. The cirrus-

sac, though provided with a stout musculature, is not very conspicuous. The cirrus has no spiny armature. The vitelline glands are, as in *P. lactuca*, distributed on either side of the testes. The position and structure of the ovary, shell-gland, and the other female generative organs is the same as in *P. lactuca*.

Phyllobothrium blakei, Shipley & Hornell.

(Plate I, fig. 5.)

Thirteen specimens from the intestine of *Trygon kuhli* trawled from Periya Paar.

Shipley and Hornell described this species in 1906 from about half a dozen specimens (half the number of which were without heads) from the intestine of *Trygon kuhli*.

The head, which we figure, bears four frilled sessile bothridia without accessory suckers. There is no neck. The proglottides do not show any overlapping at the posterior margins. The last segment is about three times as long as broad.

The disposition and arrangement of the reproductive organs is the same as in the other species of the genus. The secondary uterus is comparatively large for the size of the proglottid, and the cirrus-sac is well developed; the cirrus, however, is not echinate.

Phyllobothrium compacta, sp. nov.

(Plate I, figs. 6, 7.)

In our collections we found five specimens of a *Phyllobothrium* which cannot be assigned to any of the previously described species. We have named it *P. compacta* in view of the compact appearance of the head. The specimens were obtained from the intestine of *Trygon kuhli* trawled from Anaivilundun Paar, Ceylon (4—5 fathoms deep) on the 19th February, 1911.

The largest specimen measures 51 mm. but the others do not exceed 40 mm. The greatest width is 4 mm., and this point lies about the middle of the worm; the proglottides decrease in width posteriorly. The head has a very compact appearance owing to the sessile nature of the large and well-developed bothridia. The edges of the bothridia are slightly crumpled and there are no accessory suckers.

The specimens unfortunately are not fully mature but the anatomy as far it can be made out resembles that of *P. lactuca*.

The species may be characterised as :—Length about 51 mm., greatest breadth 4 mm., gradually decreasing to a little more than 2 mm. posteriorly. Head with four compact and sessile bothridia, without accessory suckers; neck long. There is only a slight overlapping of the proglottides. Reproductive pores lateral on alternate sides.

Habitat. Intestine of *Trygon kuhli*. November 19th, 1911.

Type-specimen in the collection of the Zoological Survey of India, Number ZEV $\frac{7255}{7}$.

LITERATURE.

1. Beneden, P. J. Van Recherches sur la fauna littorale de Belgique les vers Cestoides, etc. *Mem. Acad. Roy. Sci. Belgique.*, XXV, Brussels, 1850.
2. „ *Memoire sur les vers intestinaux*, Paris 1858.
3. Braun, M. In Bronn's Klassen und Ordnungen des Thierreichs. IV. *Vermes*. Abt. I, b, *Cestodes*, 1890-1900.
4. Johnstone, J. 14th, 15th and 18th Annual Reports, Lancashire Sea Fisheries Laboratory. *Trans. Liverpool Biol. Soc.*, 1906-1910.
5. Linton, E. Notes on Entozoa of Marine fishes of New England, with descriptions of several new species. *Ann. Rep. Com. of Fish & Fisheries*, 1886, Washington, 1889.
6. „ As above. Part II. *Annual Report*, 1887.
7. „ Parasites of the fishes of the Woods Hole Region. *Bull. U.S. Comm. Fish and Fisheries* for 1899. Washington, 1901.
8. Linstow, O. Von *Compendium der Helminthologie*, Nachtrag., 1878-1889. Hannover, 1889.
9. Haswell, W.A. On a Cestode from Cestracion. *Quart. Journ. Micros. Sci.* XLVI, 1903.
10. Shipley, A. In Willey's *Zoological Results*, Part V, 1900.
11. Shipley, A. & Hornell, J. Herdman's Ceylon Pearl Oyster Reports. Vols. II, III, & V. *Proc. Roy. Soc.*, London, 1904, 1905 & 1906.
12. Southwell, T. Description of nine new species of Cestode parasites, including two new genera, from marine fishes of Ceylon. *Ceylon Marine Biological Reports*, Pt. V. Colombo, 1911.
13. „ A short account of our present knowledge of the Cestode fauna of India and Ceylon. *Journ. Asiat. Soc. Bengal*, Vol. XX, No. 5.
14. „ Notes from the Bengal Fisheries Laboratory, Indian Museum, No. 3.—On Helminths from fish and aquatic birds in the Chilka Lake. *Rec. Ind. Mus.*, Vol. XI, 1915.
15. Yoshida, S. Some Cestodes from Japanese Selachians, including five new species.

- Parasitology*, Vol. 9, No. 4. Cambridge, 1917.
16. Zschokke, F. *Recherches sur les structure anatomique et histologique des Cestodes.* Geneve, 1888.
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